A Decade of Progress in Projections and Modeling

Hurricane Katrina: 10 Years Later

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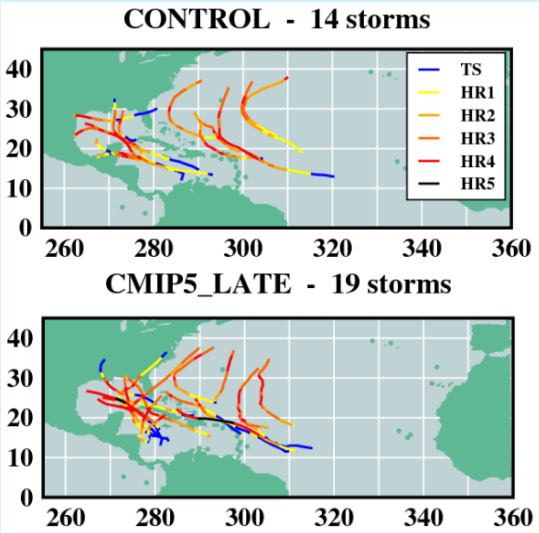
Hurricane Katrina, one of the most significant, deadly, and costly hurricanes in United States history made landfall along the Northern Gulf Coast on Monday, August 29, 2005. The storm ultimately caused the loss of over 1,200 lives and $108 billion in property damage.

NOAA is at the forefront of scientific efforts to improve the representation and accurate simulation of hurricanes in computer models and to better understand hurricane behavior and long-term expectations of hurricane occurrence.

Projections

Developing expectations for the long-term variability in strength and frequency of hurricanes is vital for mitigating their impacts through preparation and coastal planning.

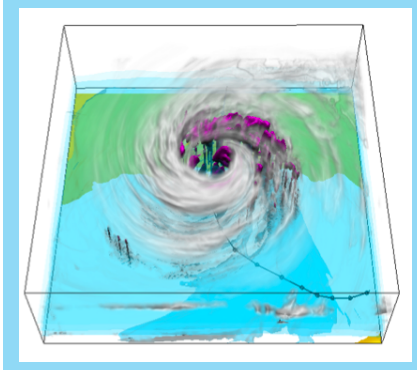
In 2005, the types of global models used to produce long-term (tens to one hundred years) projections of hurricane activity were largely unable to simulate realistic hurricanes except in some select high-resolution studies using models over a limited area. Since then, **models and computer capabilities have advanced such that global models can accurately simulate the number and intensities of hurricanes typically observed in different regions around the world.**



These images show tracks of all Atlantic hurricanes reaching at least Cat. 4 intensity in two 27-year simulations: One for the present-day climate comparison and one the late 21st century climate conditions from a CMIP5 multi-model ensemble. *Figure from Tom Knutson.*

This capability has been leveraged to build confidence in the conclusion that global hurricane frequency is expected to decrease or remain the same, while the global average intensity of storms, hurricane precipitation rates, and the number of strongest storms are expected to increase. Continuing work will refine this understanding and also explore the implications of the projected storm changes (and the magnifying effects of sea level rise) for landfalling storms and storm surge risk.

IMPROVED UNDERSTANDING



The Hurricane Weather Research and Forecasting model produces a detailed view of the conditions inside Hurricane Katrina. The capability to represent small structures inside the hurricane is critical for providing better forecasts. *Figure from Vijay Tallapragada.*

The significant, harmful impacts of hurricanes like Katrina can be mitigated through improvements to our computer models, understanding of long-term variability in hurricane behavior, and projections of future hurricane activity.

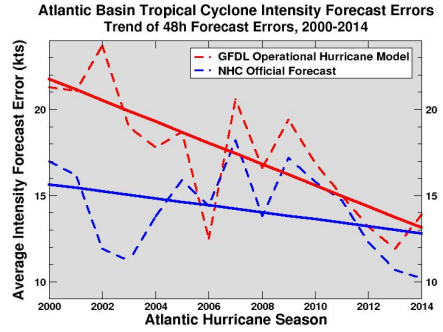
In order to make these improvements**, NOAA fosters a robust research enterprise to better understand and model hurricane variability.**

Model Development

Computer modeling of hurricanes and the environment within which hurricanes form and intensify is foundational to providing improved daily and seasonal hurricane predictions. On daily time scales, reductions in hurricane track and intensity forecast errors remain a forecast primary goal.

The model development efforts carried out in collaboration between NOAA laboratories, other federal agencies, and the university research community are critical to improving hurricane forecasts.

Reducing Errors: For many years, research enhanced the quality of hurricane track forecasts, while intensity forecast improvements lagged. New research and development since Hurricane Katrina using the Hurricane Weather Research and Forecasting (HWRF) model and the GFDL operational hurricane forecasting model has **helped to reduce errors in simulated hurricane intensity**. Increased resolution in the HWRF and GFDL models helps the models represent small-scale hurricane structures that drive the evolution of the storms. Aided by better use of aircraft observations collected in hurricanes, the models also include a **better physical representation of the atmosphere and ocean and an improved simulation of small-scale interactions between the ocean and atmosphere.**



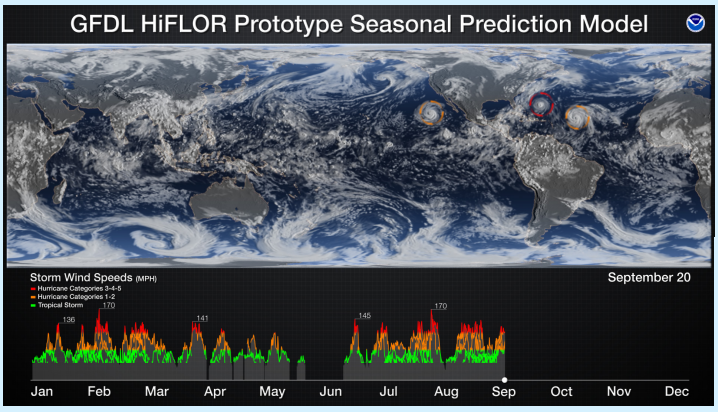
Since 2000, errors in the GFDL operational hurricane model forecast of hurricane intensity 48 hours in advance have decreased by about 40%. These improvements are likely due in large part to increased model resolution and improved model physics to better represent the hurricane inner core, and to improved storm initialization techniques. *Figure from Morris Bender.*

Expanded simulations: The HWRF model has now been expanded to simulate multiple simultaneous storms in all hurricane basins globally. This capability has resulted in further forecast improvements. In the West Pacific basin, for example, HWRF provides a significant improvement compared with existing forecast efforts and products. **Work on HWRF at NOAA's AOML and the Earth System Research Laboratory (ESRL) aims to further improve the physical representation of hurricane behavior in the model, which will lead to even better hurricane intensity and track forecasts.**

Better Predictions: GFDL has developed a number of **new systems to better predict hurricane counts and regional-scale activity months to years in advance**. These methods advance existing capabilities to provide predictions on timescales beyond weather forecasting**. Additional research and experiments with high-resolution atmospheric and climate models show promise for significant further advances in weekly to seasonal hurricane prediction capabilities over the next few years.**

GFDL's Operational Hurricane Model has seen a **40% drop** in intensity forecast errors since 2000.

Improved Outlooks: Since 2008, the development of improvements in NOAA's seasonal hurricane outlooks, which predict the overall hurricane season strength but not whether a given locality might be impacted during the season. The CFS tools, combined with GFDL climate model forecasts, now contribute to **much more accurate seasonal outlooks than those issued 10 years ago.**



New Tools: Beginning with the 2015 hurricane season, the Climate Prediction Center (CPC) has begun developing and testing a seasonal hurricane prediction tool based on the North American Multi-Model Ensemble (NMME). Development efforts for this tool are ongoing, and it is too early to assess its real-time predictive skill.

A high-resolution prototype seasonal prediction system developed by GFDL is able to realistically simulate global hurricane activity, and predict the year-to-year variations in the seasonal number of intense hurricanes in the Atlantic. This system promises to provide valuable new information for improved seasonal outlooks of hurricane activity. *Figure from Gabe Vecchi.*